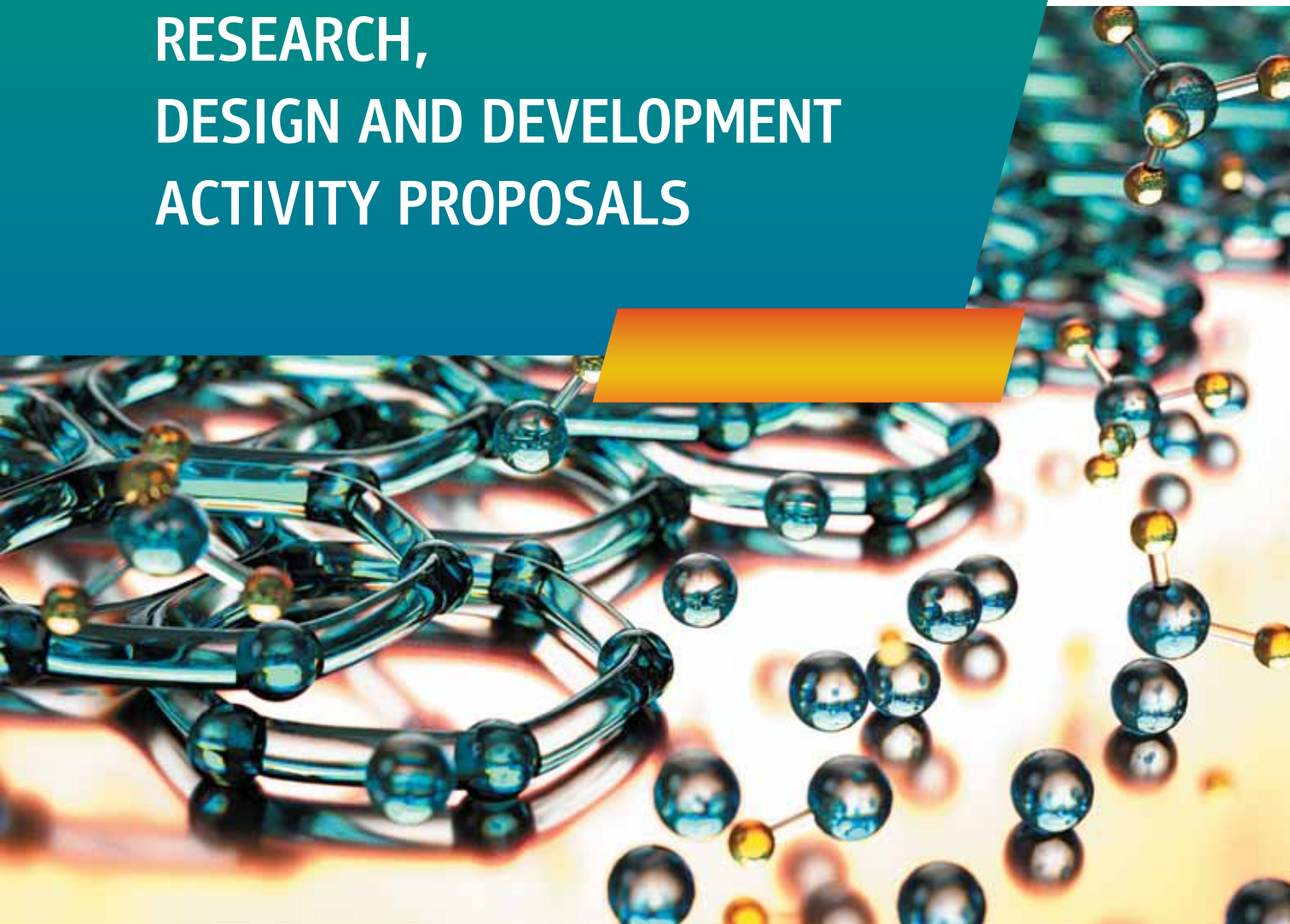
Ural Federal University

RESEARCH, DESIGN AND DEVELOPMENT ACTIVITY PROPOSALS



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INTRODUCTION

Ural Federal University (UrFU) is located in the city of Ekaterinburg, in the very heart of Russia, on the geographical border between Europe and Asia. It is one of the biggest cities in Russia, an important financial and cultural hub, as well as a perfect venue for international fairs, conferences and summits.

Ural Federal University is one of the top ranked scientific centers in Russia that strives to develop a broad scope of research subjects in natural, technical and social sciences, the humanities and economics. UrFU's state-of-the-art research infrastructure allows our scientists to carry out innovative and multidisciplinary research that attracts the interest of renowned international scientific community.

In 2013-2014 we established 12 International Laboratories headed by leading world-class researchers. In 2015 our goal is to expand our international collaborations and we would like to invite you to take part in the implementation of the following research, design and development activities. Please feel free to contact us with your proposals and suggestions!

12 International Laboratories

Laboratory of Primary Sources Research	Professor Marie-Pierre Rey, Sorbonne, France
Centre for Comparative Studies of Tolerance and Recognition	Professor Martin Van Gelderen, University of Göttingen, Germany
International Demographic Unit	Professor Gunnar Thorvaldsen, University of Tromsø, Norway
Laboratory of Multi-Scale Mathematical Modeling	Professor Peter Galenko, Friedrich Schiller University Jena, Germany
Laboratory of International and Regional Economy	Professor Dr Hans Wiesmeth, President DIU Dresden International University gGmbH, Professor at the Technical University Dresden, Germany
Climate and Environmental Physics Laboratory	Professor Jean Jouzel , Nobel prize co-winner, Institut Pierre Simon Laplace, France
Nanoscale ferroelectrics laboratory (NANOFER)	Professor Andrey Kholkin, University Aveiro, Portugal
Research Laboratory of Advanced Low-Dimensional Materials and Nanostructures	Professor Lars Hultman, CEO of The Swedish Foundation for Strategic Research, Linköping University, Sweden
Laboratory of Chemical Design of New Multifunctional Oxide Materials	Professor Bernard Raveau, University of Caen, France
Laboratory of Magnetic Sensors	Professor Manuel Vazquez Villalabeitia, Institute of Material Studies of the Spanish National Research Council, Spain
MIFE - Laboratory for Membrane Transport and Stress Biology Research	Professor Sergey Shabala, University of Tasmania, Australia
Laboratory of Molecular Mechanisms of Morphogenesis	Professor Alexander Kinev, CEO of the independent research corporation Creative Scientist Inc., USA

Research, design and development activity proposals

No	Activity	Description
1	Development of a voltammetric sensor based on carbon nanotubes for the identification of metal traces	As demonstrated in a number of works published in recent years, the modification of glassy carbon and thick-film electrodes (TFE) with carbon nanotubes (CNT) made it possible to lower the limits of detection of heavy metals by the anodic stripping voltammetry (SV). The objective of the project is to study the impact of the morphology of carbon nanotubes (CNT) on the analytical characteristics of the proposed electrodes. Taking into account the high adsorption capacity of CNTs, we first proposed the use of the material in the adsorption SV based on the adsorption concentration of the complex compound of the ion of the determined metal with a selective metal organic reagent on the TFE surface. **Professor Alisa Kozitsina,** **Institute of Chemical Technology**

No	Activity	Description
2	Study of the catalytic properties of potassium thiocyanate, nickel salts (II) and cobalt (II) in the solution in an aprotic medium and gold and silver nanoparticles of different composition in an aqueous-organic emulsion for the electrochemical oxidation of cholesterol.	The project is aimed at developing azymous receptors for the determination of cholesterol namely a synthesis of gold and silver nanoparticles of different composition (nanoalloys, and 'core-shell' particles), their immobilisation on the working electrode and a study of their electrochemical reactions in the aqueous-organic emulsion, a study of the electrochemical transformation of nickel and cobalt and potassium thiocyanate in an aprotic medium and catalytic electrochemical reactions occurring in the presence of cholesterol. The novelty of the proposed project consists in forming on conductive substrates (based on carbon-containing electrodes and modified carbon nanotubes) of the fundamentally new azymous receptors containing metal nanoparticles, potassium thiocyanate or nickel salts (II) or cobalt (II) followed by the catalytic electrochemical oxidation of cholesterol and receipt of an analytical signal. Data will be obtained on the mechanism of electrochemical transformations of new receptors with the desired properties, catalytic electrochemical reactions and effect of several parameters on their course. In this project, cyclic voltammetry methods will be used for a better understanding of the processes occurring at the electrode-solution interface. In the course of the project implementation it is expected: • To synthesise gold nanoparticles (AuNP), silver (AgNP), gold-silver nanoalloys (Ag/AuNP) and 'core-shell' nanoparticles (Ag@AuNP and Au@AgNP) to be used as electrocatalysts for the electrochemical oxidation of cholesterol. • To study the electrocatalytic activity of gold nanoparticles (AuNP), silver nanoparticles (AgNP), gold-silver nanoalloys (Ag/AuNP) and the 'core-shell' nanoparticles (Ag@AuNP and Au@AgNP) immobilised on the surface of the working electrode in the aqueous organic emulsions, potassium thiocyanate and the salts of nickel (II) and cobalt (II) in the solution volume in an aprotic medium. **Professor Alisa Kozitsina,** **Institute of Chemical Technology**

No	Activity	Description
3	Creation of effective heat transfer and temperature control systems based on heat pipes to cool thermally charged elements in different areas of the industry (LED lighting, space vehicles, supercomputers, nuclear power, lasers etc.)	The objective of this project is the development of two-phase thermal control systems with the capillary and (or) gravitational mechanism for coolant transport. During the realization of the project we expect to simplify the technology to produce cooling (temperature control) systems and create an innovative system for the collection, transport and release of heat with low power consumption, price, weight and size properties, high reliability and long life due to the absence of mechanical components. One of the unique characteristics of this project is the fact that no additional energy sources will be used to transfer the coolant. **Professor Valery Kiseev,** **Institute of Natural Sciences**
4	Development of thermally stable precision casting alloys	The project has 3 main objectives: • First, the development of precision casting alloys for the manufacture of parts of ships and submarines with a pre-determined temperature coefficient of linear expansion (TCLE) from 0.5 x 10-6K-1 to 8.5 x 10-6K-1 in the temperature range of 20-1000C, a reduced TCLE in the temperature range from 20 -200oC to 20-500oC and an increased corrosion resistance. • Second, the development of casting technologies for new alloys. • Third, the development of technologies for the manufacture of welded-cast structures of new alloys. **Professor Alexander Petunin,** **Institute of Mechanics and Machine Building**

No	Activity	Description
5	Technology development of the hydropneumoabrasive surface treatment technology for removal of the oxidation film before welding. The effect of hydropneumoabrasive surface cleaning on the coating's adhesion properties.	In the course of the project the following activities will be carried out: • Study of the impact of the hydropneumoabrasive surface preparation on weld quality. • Comparison of adhesion properties between the coatings put on the surface obtained through hydropneumoabrasive cleaning and a classical method. • Development of the hydropneumoabrasive equipment to remove oxide film before welding. • Testing the hydropneumoabrasive surface cleaning modes depending on the strength properties of materials. **Professor Alexander Petunin,** **Institute of Mechanics and Machine Building**
6	Development of optimal manufacturing technologies to produce body sub-products	In the course of the project the following activities will be carried out: • Development of methods to optimise the cutting of sheet materials into the hull blanks. • Development of algorithms for routing the tool for thermal material cutting machines with computer numerical control (CNC). • Development of software for the optimization of time and cost of cutting with CNC-controlled machines. **Professor Alexander Petunin,** **Institute of Mechanics and Machine Building**

No	Activity	Description
7	Development of a maintenance-free meteorological set based on custom-tailored radioacoustic atmospheric sounding	The objective of this project is to develop a prototype of the compact mastless maintenance-free meteorological set based radioacoustic atmospheric sounding allowing for the remote non-contact measurement of wind and temperature profiles in the atmospheric boundary layer (up to 1 km), atmospheric humidity and barometric pressure and transmit the data via radio. The system will be designed to automatically collect meteorological data (wind speed profiles, wind direction, temperature, humidity and pressure). **Professor Vyacheslav Ivanov,** **Institute of Radioelectronics and Information Technologies**
8	Research of the protective properties of zinc-rich coatings and development of a method for producing metal powder fillers	This project's aims are: • to choose the electrolysis conditions for finely divided precipitates; • to justify the choice of the polymeric binder; • to carry out a comparative analysis of the properties of zinc-rich tread compositions based on experimental studies and model description of the growth of dendritic deposits of zinc. The use of powder obtained through electrolysis will reduce the critical volume fraction of the pigment in the paint and coatings composition by 3 times while maintaining the protective properties and electrical conductivity of coatings **Professor Oksana Iaroslavtceva,** **Institute of Chemical Technology**

No	Activity	Description
9	Development of a method to evaluate the resistance of steel to local forms of corrosion	During the realization of this project the following research will be conducted: • observation of periodic current oscillations at a certain anode potential that cause the formation of pits. • A mathematical analysis of current oscillations that will develop and determine a criterion for pitting. The results of this research will determine the pitting resistance of steels in the method. **Professor Valentin Rudoy,** **Institute of Chemical Technology**
10	Research into cavitation to improve the efficiency of chemical, petrochemical and biochemical technologies	The project has 2 main objectives: • Identification of mechanisms to improve the chemical, petrochemical and biochemical technologies under the cavitation influence of optimal parameters. • Development of projects and production of prototype models of equipment. **Professor Valeriy Nikulin,** **Institute of Chemical Technology**

No	Activity	Description
11	Development of methods for monitoring and evaluation of the technical condition of sophisticated technological systems	In the course of the project implementation it is expected to: • Identify the data parameters characterising the technical condition of the sophisticated man-made objects. • Develop systems for the collection and monitoring of the data parameters characterising the technical condition of the sophisticated man-made objects. • Develop algorithms for processing the measurement data collected by monitoring systems. • Develop software tools for the analysis of measurement data and evaluation of the technical condition of sophisticated technological systems. **Professor Sergey Porshnev,** **Institute of Radioelectronics and Information Technologies**
12	Contactless radio-wave sensor for the measurement of vibration parameters and displacements	This project will focus on the creation of a radio-wave proximity sensor to measure vibration and movement of objects under the low- and very high temperature conditions or in the corrosive and explosive environments over long distances in order to measure dynamic vibrations during testing and launching at several test points of the object at the same time. The development plan: the use of non-linear multi-frequency radar in conjunction with artificial non-linear scatterers located at controlled points (dimensions 1÷2 cm in diameter, 0.1÷0.2 mm thick, resistant to the temperature of thousands of degrees) and provide a measurement range up to 100 m, and the viewing angle of tens of degrees. **Professor Sergey Porshnev,** **Institute of Radioelectronics and Information Technologies**

No	Activity	Description
13	Development of an automatic system for the contactless measurement of geometrical parameters of large items during manufacture	This project includes the development of a system based on optical proximity sensors for the automatic contactless measurement of the geometrical parameters of large-sized items used in production, to control the maximum dimension of bulky cargo in transportation systems, etc. The measurement results will be transmitted to the automated production control system over a communication channel and through a radio channel as well. **Professor Alexey Kalmykov,** **Institute of Radioelectronics and Information Technologies**
14	Development of a technology for coating of metal compounds on the polymer film surface by ion-plasma sputtering	The purpose of this project is to develop a technology for metal compound coating by ion-plasma sputtering on the surface of thin polymer films which could be used in the processes of gas filtration, selective electrochemical filtration of solutions, etc. (enterprises in the area of gas production, oil production, as well as those of the radiochemical, environmental, hydrogeological and microbiological profile). **Professor Nikolai Khlebnikov,** **Institute of Fundamental Education**
15	Development of a technology for the creation of composite films and coatings with specific physical and chemical properties applied through plasma methods	This project is dedicated to the development of composite films and coatings with specific physical and chemical properties applied through various plasma methods for protective, strengthening, biocompatible, hardness, wear-resistant, heat-resistant, corrosion-resistant purposes. **Professor Nikolai Obabkov,** **Institute of Physics and Technology**

No	Activity	Description
16	Integrated optimisation of energy consumption for a remote residential facility in order to ensure sustainable energy supply through alternative renewable energy sources	The objective of this project is to comprehensively optimise the energy consumption for a remote residential facility which includes the optimisation of architectural and planning solutions, the issues related to the choice of thermal protection materials for the facility, the selection of the optimal voltage level of the (internal) power network, the selection of an optimal level of power including the need for back-up heat and electricity. An optimal structure of energy supply for the facility will be developed by a combination of different energy units and systems. **Professor Vladimir Velkin,** **Ural Power Engineering Institute**
17	Research into the wave potential of seas and oceans based on the research of the wave buoy	The project has 2 aims: • To obtain a wave energy map for seas and oceans. • To develop a multi-purpose wave energy generator for different areas of the world ocean. **Professor Sergei Shcheklein,** **Ural Power Engineering Institute**
18	Technology to build a combined robotic unit designed to ensure the operation of the river transport, harbour basins and fairway	This project includes the development of a flexible technology to create algorithms and software providing integrated management of the distributed systems that include a set of stand-alone and/or remote-controlled stations for monitoring, process control subsystem for communication, analysis of the state and response to changing circumstances. This technology will be applicable to meteorological, hydrological, environmental and event-related tasks (for search and rescue operations) monitoring the fairway and water areas of the river basin. **Professor Sergey Kruglikov,** **Graduate School of Economics and Management**

No	Activity	Description
19	Development of the energy-efficient synchronous reluctance drive	This project aims to develop a low-cost (cheaper and more affordable compared to the ones available on the market) SynRM high-class energy efficiency (IE3 or higher). **Professor Vladimir Prakht,** **Ural Power Engineering Institute**
20	Development of a diagnosis method of the technical state of asynchronous motors based on the consumed stator current	The following activities will be carried out during the realization of the project: • Development of new diagnosis methods and software-hardware system that will allow to run diagnostics of asynchronous motors with a short-circuit rotor based on the consumed stator current • Calculation and justification of the technical and economic effect of the implementation of this method of asynchronous motor diagnosis on the example of industries. **Professor Vladimir Prakht,** **Ural Power Engineering Institute**
21	New soft magnetic composites and electric machines made of these materials	This project is dedicated to invention of new soft magnetic composites (hereinafter referred to as the “SMC”) with improved features, such as: increased level of specific electrical resistance of SMC; obtain materials with increased value of the saturated flux density of SMC in comparison to analogues; reduce the cost of production SMC in comparison to analogues. **Professor Vladimir Prakht,** **Ural Power Engineering Institute**

No	Activity	Description
22	Glass-ceramic lead-free materials with high energy density	The goal of this project is to obtain aluminosilicate glass-ceramic materials based on lead-free compositions with a high energy density. The influence of the glass-ceramics composition and the synthesis parameters on the microstructure, domain structure and dielectric properties will be studied. These results will be used for the development of new technologies for the preparation of highly effective glass-ceramic materials to be applied in power electronics and energy storage devices. **Professor Vladimir Shur,** **Institute of Natural Sciences**
23	New composite biomaterials for medical applications	The present project is focused on the development of new composite biomaterials for the production of implants based on a porous structure and hydroxyapatite. **Professor Nikolai Khlebnikov,** **Institute of Fundamental Education**
24	Fabrication and application of composite track membranes	The realization of this project will lead to a wider range of possibilities to apply track membrane materials, based on new functional properties of the composite material, derived from the combination of the polymer track membrane structure and a functional metallized coating. **Professor Nikolai Khlebnikov,** **Institute of Fundamental Education**

No	Activity	Description
25	Memristor elements based on oxide nanotubular structures	In the course of this project, memristor matrixes will be developed on the basis of oxide nanostructures (titanium dioxide, zirconium) in order to create an energy dependent computer memory, including the development of technological documentation for the preparation and fabrication process of such prototype matrixes. **Professor Ilya Weinstein,** **Institute of Physics and Technology**
26	Subbackground detection system of radiation environment in residential areas adjacent to nuclear power plants, including a block of neutron detectors based on He-3 counter and optional unit scintillation gamma-radiation	During the realization of this project neutron subbackground detection systems and an optional unit of gamma-radiation with enhanced sensitivity (up to 10% of the background) will be developed. The optional unit will consist of a mobile neutron registration block based on He-3 counters and an optional scintillation gamma-radiation registration unit, as well as a data processing and transmission unit with a wireless communication channel. **Professor Boris Shulgin,** **Institute of Physics and Technology**
27	Experimental and theoretical research of integration technologies of renewable energy units into building support systems for severe weather conditions	The aim of this project is to conduct experimental and theoretical research of the integration technologies of renewable energy units into the building support systems for severe weather conditions in order to adapt them to the traditional systems of energy supply. **Professor Vladimir Velkin,** **Ural Power Engineering Institute**

No	Activity	Description
28	OSL-sensors for monitoring systems of local radiation dose of the treated organs in interstitial brachytherapy	During this project, precise detection elements for medical OSL doses express-monitoring systems of local radiation effect in interstitial brachytherapy will be developed, including documentation and fabrication of detector prototypes. **Professor Ilya Weinstein,** **Institute of Physics and Technology**

Notes

PRIORITY AREAS

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